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MANUSCRIPT THESIS

A Collection of Idaho Aphididae And

The Economic Treatment For Plant Lice

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Bachelor of Science in Agriculture in the

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by

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A COLLECTION OF IDAHO APHIDIDAE AND THE ECONOMIC TREATMENT FOR PLANT LICE.

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SECTION 1.

COLLECTION AND CLASSIFICATION.

1. Collection of Aphides.

The collection consists of about 70 vials containing specimens of aphides preserved in 70% alcohol. Seventeen gerera and 34 species are represented. Besides this there are 9 specimens whose genera, only, are determined. There are representatives of 6 of the 7 sub-families of the family aphididae. About 10 of the vials, belonging to the University of Idaho collection, are classified and considered with the rest.

The few aphides of the original University collection were obtained at intervals sometime before the collection made for this thesis. The latter were collected between June 5 and November 2, 1911.

Most of the specimens were taken in two localities - in the neighborhood of Moscow, Latah Co. and Kimberly, Twin Falls Co. Kind acknowledgement is made of a few specimens collected at Preston, Oneida Co. by J. R. Maughan; at Boise, Ada Co. by Miss Edna Larson; and at Moscow by E. C. Hall.

It was the intention to take field notes as the specimens were collected, giving such information as, the host plant; the date of collection; color, size, and abundance of the aphides; other insects found with the aphides; damage done to the host plant; and other information that was considered of importance. The intention was but poorly carried out. In some cases there is even uncertainty as to the host plant. Where collections were made by others, notes are almost or entirely

lacking.

The vials are numbered to correspond with the description. The labels contain the numbers, names, host plants, and dates of collection.

2. Classification and Descriptions.

A. Determination of Genera and Species.

For the work of classification the author is indebted to Professor C. P. Gillette of the Colorado Agricultural College and Professor H. F. Wilson of the Oregon Agricultural College. The collection was first sent to Prof. Gillette who determined about one half of them. The rest, with those of which Prof. Gillette was not certain, were sent to Prof. Wilson. In some cases determinations were difficult, and in others it was impossible to determine the species. This was due, in a great degree, to the few specimens, poor condition of the insects, or to uncertainty as to the host plants.

The following specimens were determined by Prof. Gillette, Nos. 1,2,3,4,5,7,9,10,12,14,16,18,19,25,26,28,29,30,31,32,33, 34,35,37,38.

The following specimens were determined by Prof. Wilson, 2,6,8,11,12,13,14,15,17,20,21,22,23,24,26,27,29,31,36,37,38, 39,41 (Pemphigus).

The following were determined by both:

1. Those agreed upon, 26,29,31,37.

2. Those on which they differ:

No.	Gillette.	Wilson.

2. Macrosiphum sanborni or Aphis sanborni.

5. Aphis medicaginis(?) or Myzus cerasi.

12. Aphis medicaginis(?) or Aphis Pomi.

14. Chaitophorus viminalis(?) or Chaitophorus cordatae(?)

38. Macrosiphum species or Nectarosiphon species.

The following were determined by myself, 41(Nectarosiphon and Schizoneura lanigera), 42,43. After examination of the specimens in question, I decided in favor of the underlined names.

B. Names and Descriptions.

1. Aphis avenae Fab. European grain louse.

a.Wheat and Oats.Moscow, College greenhouse,Oct. 17, 1911.
Green to dark brown; very few; winged and wingless; doing considerable damage to grain.

b.Apple tree. Kimberly, June 13.
Brown to light green; few; no winged ones seen; on young shoots in shady part of tree.

2. Macrosiphum sanborni Chrysanthymum.

a.Moscow, College greenhouse, June 5.
Black; very numerous; all wingless; with larvae feeding on them.

b.Moscow, Bourne's greenhouse, Oct. 17.
Light green to dark brown, shining; many sizes; very numerous; few winged; on young stems more than leaves; leaves sticky with secretion; apparantly little or no damage done.

3. Schizoneura americana Riley.American elm louse.American elm.

a.Moscow, June 6.

Woolly; several sizes; very numerous; wingless; leaves badly infested, curled and covered with sticky secretion; trees badly damaged.

b.Kimberly, June 22.

Woolly; many sizes; nery numerous; winged and wingless; leaves badly curled; cloudy, globular masses of liquid on leaves.

c.Moscow, Aug. 28. Trunks of elm and Lombardy poplar.

Numerous on elm; all winged; in crevices on bark; especially numerous near ground; very active during sunshine on warm days, alighting on clothing of people passing.

d.Moscow, Sept. 18. Elm trunk with No. b.

Extremely small; none winged; in crevices of bark; few; oviporous male and female.

4. Chaitophorus negundinis Thos. Boxelder. Moscow, June 9.

Wingless light green; winged with dark head and thorax; many sizes; larvae feeding on them.

5. Myzus cerasi Fab. Sweet cherry. Moscow, June 9.

Jet black; young a little lighter colored; few winged; larvae of a fly, one took an offered aphis; leaves very sticky.

6. Aphis pruni Koch (?). Prune tree. Kimberly, June 13.

Light green; some winged; grayish blue larvae and lady beetles present; young leaves considerably damaged.

7. Myzus persicae Sulz. Green peach aphis. Peach tree. Kimberly, June 13.

Light green; numerous; no winged ones seen; on upper and lower surfaces of leaves.

8. Hyalopterus pruni (Fabr.). Prune tree. Kimberly June 14.
Green; above medium size; no winged ones seen; very numerous.

9. Aphis sorbi Kalt. Rosy apple aphis. Apple tree.
a. Kimberly, June 18.
Reddish brown to dark brown, young lighter colored; many sizes; rather numerous; active; no winged ones seen; large larvae and ants present.
b. Kimberly, June 21. Pink; many sizes; numerous in places; few winged; many larvae and black ants present; mostly on veins of leaves.

10. Schizoneura lanigera Hausm. Woolly aphis of apple. Apple tree, Kimberly, June 18.
Woolly, in white masses; no winged ones seen; in rough place on bark and in axils of limbs; inactive; much "wool"; on same tree as 9a.

11. Aphis carbocolor Gillette. Sour dock. Kimberly, June 20.
Dark brown to intensely black; many sizes; very numerous; congregated; few winged; many larvae; active; mainly on branches.

12. Aphis medicaginis Koch. Pear tree. Kimberly, June 25.
Brown to black; few; black ants present; on tips of shoots.

13. Macrosiphum (species unknown). and Aphis (species unknown). Sage brush. Kimberly, June 23& 24.
Two kinds; (1) black to greenish black; some winged.

(2) Exact color of sage brush, almost invisible; few; some winged. On leaves and stems; black ants present.

14. Chaitophorus viminalis Monell. Willow.

a. Kimberly, June 27.

Reddish brown, winged ones black; all sizes; very numerous few winged; ants present; on stems at base of branches; rather active.

b. Kimberly, June 27.

Dark brown to black; very numerous; few winged; ants and flies present; active; on stems at base of branches.

15. Macrosiphum luteola Williams. Golden rod. Kimberly, June 28.

Dark brown to wine color; very large; few winged; larvae present, on stems and lower leaves; rather active.

16. Macrosiphum lactucae (Kalt.??) Lettuce. Kimberly, June 16.

Green; manny sizes; few; very few winged; larvae present; on under side of leaves.

17. Schizoneura populi Gillette. Carolina poplar. Kimberly 23.

Light green; developed from straw colored bodies, fluffy, that were discovered on trunks of trees in June; small; very numerous; wool profuse, making it difficult to see insects; in low places in bark of trunk.

18. Aphis brassicae Linn. Cabbage lice. Cabbage. Moscow, Sept. 26.

Color of leaf; very numerous in places, in colonies; very few winged; many parsitized, showing valved openings; some plants not infested.

19. Phorodon humuli Schr. Hop aphis. Hops. Moscow, Sept. 28.

Light green; many sizes; no winged ones seen; on under

side of leaves near veins; no apparent damage to plant, leaves not curled.

20.Aphis (species unknown). Vicia (?). Near the Twin Falls. Kimberly, July 1.

Brownish; rather numerous.

21.Eucallipterus tiliae Linn.

a. Ash. Moscow park, Sept. 30.

Few but well distributed over tree; many sizes; some winged.

b. Rock elm. Moscow park, Sept. 30.

Very few; many sizes; some winged.

22.Drepanosiphum plantinoides Schr. Maper tree. Moscow park, Sept. 30.

Very few; many sizes; some winged.

23.Nectarosiphon rubicola (Oest.). Thimble berry (Rubus parviflorus). In woods east of Poe station, about 4 miles from Moscow. Oct. 6.

Light yellow; large and small; very few; no winged ones seen except 2 or 3 dead; on under sides of leaves near veins.

24.Pemphigus (species unknown, may be new-Wilson). Catnip (Nepeta cataria). In woods east of Poe station, Oct. 6.

Light brown; very few; all winged; on under sides of leaves.

25.Myzus rosarum (Walk.) Red garder rose. Moscow, Oct. 6.

Light green to yellow; few very few winged; on juder side of leaf.

26.Macrosiphum (species unknown). Aster. Bourne's greenhouse. Moscow, Oct. 8.

Green, some with gray backs; many sizes; few; very few winged.

27. Rhopalosiphum persicae Sulz. Red pepper, green pepper, egg plant. College greenhouse, Moscow, Oct. 17.

Light green, few light brown, shining; many sizes; few winged ones; on young stems more than leaves; leaves sticky with secretion; apparantly little or no damage done.

28. Pemphigus (species unknown). and Myzus persicae Sulz. Verbena. Ornamental grounds south of Administration building, U. of I. Moscow, Oct. 8.

Light green to brown; large and small; very few; 4 winged ones seen and taken; underside of leaves and tips of stem.

29. Myzus ribis (Linn.). Currant aphis. Currant.

a.Red currant. Moscow, June 14, 1908.

Mostly green; one winged; Cause peculiar distortion of leaves.

b.Red currant. Weston, Ida.

Leaf much distorted.

c.Wild currant. Moscow mountain, June 28.

Light green.

30. Pemphigus venafuscus Patch. Moscow.

a.Flying in street, Oct. 25.

Large woolly; few smaller, black, and without wool.

b.Ash, Nov. 2.

Winged are woolly; many others smaller, green and light brown, probably sexual generation; very numerous; covering large surface on tree trunk; living thru very cold

nights.

31. Pemphigus (species unknown, may be new-Wilson). Boxelder. Diamond, Washington. July 5, 1908.

Grayish blue; in galls on stems.

32. Aphis cerasifolia Fitch. Chokecherry. July 3.

Leaves rooled up.

33. Aphis atriplicis Linn. Pigweed (Chenopodium album). Aug.26.

Leaves considerably wrinkled.

34. Melanoxantherium bicolor Oest. Cottonwood. Moscow, Aug. 19, 1903.

Large, black.

35. Myzus cerasi (Fab.). Sweet cherry. June 28, 1908.

Dark brown; large and small.

36. Macrosiphum rosae (?) Linn(?) Rose, garder. Preston, July 4.

37. Aphis (species unknown). Aster. Ornamental grounds south of Administration building U. of I. Moscow, Oct. 18.

Light green to light brown; very numerous in places; about 3 winged ones seen and collected; mostly in angles between stems.

38. Macrosiphum (species unknown). Huckleberry, July 25.

Green.

39. Hyalopterus aquilegiae-flavus (Kittel) (?). Rose, garden. Moscow, June 9.

Light green; many sizes; active; leaves folded along mid-rib and stuck together along edge; leaves droping, plant much damaged.

40. Phylloxera vastatrix. European grape. Juliaetta.

Brown; very small; on roots.

41. Pemphigus (species unknown) and Nectarosiphon (species unknown). and Schizoneura americana. Petunia. Moscow, Oct. 9. Some woolly, others with black thorax and yellow abdomen; few, but widely distributed on plant; all winged; nearly all dead.

42. Coloradoa, Wilson (?) (species unknown). Rabbit brush. At the Twin Falls, near the bottom of the descending path. Young green; older brown and black; none winged; on tender shoots at bases of leaves; leaves curled up; brown and red ants numerous.

43. Pemphigus (species unknown) Lombardy poplar. Oxford, 1904. Causing globular, granulated, distinctly lobular galls on ends of branches.

3. Classification of Family Aphididae.

The classification of the sub-families Rhizobiinae, Chermaphinae, Pempheginae, Schizoneurinae, and Lachinae is that given by W. D. Hunter in Iowa bulletin 60,"Aphididae of North America", 1901. The sub-families Aphidinae and Callipterinae are given according to the recent work of Prof. H. F. Wilson: Key to Genera of Sub-family Aphidinae", Annals of Entomological Society of America, December, 1910; "Key to Genera of Tribe Callipterini" sub-family Callipterinae, Canadian Entomologist, No. 8, Vol. 24, August, 1910; "Key to Genera of Tribes Pterecommini, Chaitophorini, and Vacuini"sub-family Callipterinae, Canadian Entomologist, No. 12, Vol. 24, December, 1910.

Family Aphididae, Order Hemiptera, Class Insecta.

Sub-family Rhizobiinae (subterannean, apterous).

Genus Rhizobius.

Tychae.

Forda.

Trama.

Sub-family Chermaphinae (antennae 3-5 jointed, fore wing with only 2 discoidal veins).

Genus Phylloxera (gall-making aphides).

Chermaphis (or Chermes). (coniferous aphides).

Sub-family Pemphiginae (antennae 6-7 jointed, fore wing with 3 discoidal veins, third simple). Gall-making aphides.

Pemphigus (gall-making aphides).

Genus Tetraneura.

Hormaphis.

Geoica.

Sub-family Schizoneurinae (antennae 6-7 jointed, fore wing with 3 discoidal veins, third with 1 branch). Aphides that produce a flocculent exudation and curl leaves.

Genus Schizoneura.

Colopha.

Sub-family Lachninae (antennae 6 jointed, fore wing with 3 discoidal veins, third with 2 branches).

Genus Lachnus.

Phyllaphis.

Sub-family Aphidinae.

Tribe Trichosiphini (nectaries nearly as long as the body, with long hairs).

Genus Trichosiphum.

Greenidea.

Tribe Macrosiphini (nectaries without hairs, not more than half as long as body, at least 1/4 length of body; antennae as long as body or longer, and on distinct turbercles).

Genus Illinoia.

Nectarosiphon.

Macrosiphum.

Idiopterus.

Microparsus.

Pentalonia.

Amphorophora.

Toxoptera.

Phorodon.

Rhopalosiphum.

Myzus.

Tribe Aphidini (Differing From T. Macrosiphini in having antennae generally not on tubercules. When tubercules are present antennae and nectaries much reduced).

Genus Liosomaphis.

Hyadaphis.

Aphis.

Pergandeida.

Mastopoda.

Coloradoa.

Cerosipha.

Hyalopterus.

Brachycolus.

Microsiphum.

Cryptosiphum.

Carolinaia.

Sub-family Callipterinae.

Tribe Callipterini.

Genus Drepanosiphum.

Drepanaphis.

Calaphis.

Euceraphis.

Myzocallis.

Eucallipterus.

Chromaphis.

Callipterus.

Monaphis.

Monellia.

Tribe Pterocommini.

Genus Melanoxantherium.

Pterocomma.

Tribe Chaitophorini.

Genus Arctaphis.

Chaitophorus.

Symdobius.

Thomasia.

Sipha.

Tribe Vacunini.

Genus Glyphina.

Vacuna.

SECTION 11.

HOST PLANT INDEX AND KEY.

1. Host Index.

Apple - Aphis avenae, 1; Aphis sorbi, 9; Schizoneura lanigera,10.

Ash - Eucallipterus tiliae, 21; Pemphigus verafuscus, 30.

Aster - Aphis species, 37; Macrosiphum species, 26.

Boxelder - Chaitophorus negundinis, 4; Pemphigus species, 31.

Cabbage - Aphis brassicae, 18.

Catnip (Nepeta Cataria) - Pemphigus species, 24.

Cherry, Sweet - Myzus cerasi, 5, 35.

Chokecherry - Aphis cerasifoliae, 32.

Chrysanthymum - Macrosiphum sanborni, 2.

Clematis - Specimens lost.

Cottonwood - Melanoxantherium bicolor, 34.

Currant, Garder - Myzus ribis, 29.

Wild - Myzus ribis, 29.

Dock, Sour (Rumex) - Aphis carbocolor, 11.

Egg plant - Rhopalosiphum persicae (greenhouse), 27.

Elm, American - Schizoneura americana, 3; (greenhouse)
Rhopalosiphum persicae, 27.

Rock (?) - Eucallipterus tiliae, 21.

Goldenrod - Macrosiphum luteola, 15.

Grape, European - Phylloxera vastatrix, 40.

Hops - Phorodon humuli, 19.

Huckleberry - Macrosiphum species, 38.

Lambsquarter or pigweed (Chenopodium album) - Aphis atriplicis, 33.

Lettuce - Macrosiphum lactucae, 16.

Maple, Soft - Drepanosiphum platinoides, 22; (greenhouse) Rhopalosiphum persicae, 27.

Oats - Aphis avenae, 1.

Peach - Myzus persicae, 7.

Pear - Aphis medicaginis, 12.

Pepper, Red - Rhopalosiphum persicae, 27.

Green - Rhopaposiphum persicae, 27.

Petunia - Pemphigus species, 41; Schizoneura americana, 41; Nectarosiphum species, 41.

Pigweed or Lambsquarter (Chenopodium album) - Aphis atriplicis, 33.

Pine, White - Lachnus.

Poplar, Carolina - Schizoneura populi, 17.

Lombardy - Pemphigus species, 43.

Prune - Aphis pruni, 6; Hyalopterus pruni, 8.

Rabbit brush (Chrysothamnus) - Coloradoa (?), 42.

Rose Garden - Myzus rosae, 25; Hyalopterus acquilegiae-flavus (?) 39; Macrosipmum rosae, 36.

Sage brush (Artemesia) - Aphis species, 13; Macrosiphum species 13.

Sour dock (Rumex) - Aphis carbocolor, 11.

Tamarack or Larch - Lachnus.

Thimbleberry (Rubus parviflorus) - Nectarosiphon rubicoli,23.

Unknown plant - Aphis ribis.

Verbena - Myzus persicae, 28; Pemphigus species, 28.

Vicia (?) - Aphis species, 20.

Wheat - Aphis avenae, 1.

Willow - Chaitophorus viminalis (?), 14.

2. Key to Genera In Collection.

Sub-families.

1	Winged form unknown; subterranean species - Rhizobiinae,	A.
	Winged form known; aerial in habit	2.
2	Antennae 6 or 7 jointed; fore wing with 3 discoidals -	3.
	Antennea 3 to 5 jointed; fore wing with only 2 discoidals - Chermaphinea,	B.
3	Third discoidal simple; Pemphiginae,	C.
	Third discoidal branched -	4.
4	Discoidal twice branched -	5.
	Discoidal with only one branch - Schizoneurinae,	D.
5	Antennae 6 jointed - Lachninae,	E.
	Antennae 7 jointed (in Sipha 6)	6.
6		

Division of Sub-families.

A. Rhizobiinae - no specimens collected.

B. Chermaphinae,

Antennae 3 jointed - Phylloxera.

Antennae 5 jointed- Chermaphis (or Chermes)

C. Pemphiginae.

Hind wing with 2 discoidals - Pemphigus.

D. Schizoneurinae -

Hind wing with 2 discoidals - Schizoneura.

E. Lachninae.

Stigmal vein straight; abdomen bare - Lachnus.

F. Aphidinae.

Antennae as long as body or longer (shorter in Phorodon), and set on distinct tubercles - Tribe Macrosiphini, 1.

Antennae usually shorter than body, not on distinct tubercles. When tubercles are present antennae and nectaries much reduced - Tribe Aphinini, 2.

Genera of Above Tribe.

1. Macrosiphini.

Antennal tubercles tapering and very large; not gibbous on inner side. Nectaries at least one-fourth length of body and vasiform - Nectarosiphon.

Antennal tubercles gibbous or toothed on inner side.

Antennal tubercles large; as long on outer side as on inner; upper inner angle more or less gibbous. Nectaries variable, tapering longer than cauda. Wings regular, cubitus twice forked - Macrosiphum.

Antennal tubercles not large but prominent; inner side longer than outer, or else outer side but a line.

Antennal tubercles wedge-shaped with inner side formed into a tubercle or tooth. Cauda short.

Antennal tubercles with strong tooth on inner side; nectaries almost cylindrical but tapering slightly. Cauda short, tapering - Phorodon.

Antennal tubercles with a prominent, blunt projection forming inner side. Nectaries slightly clavate; cauda tapering and with a knobbed tip Rhopalosiphum.

Antennal tubercles with distinct, not prominent,

blunt projection forming inner side of tubercle; (more prominent in wingless forms). Nectaries cylindrical, slightly curved at tip. Cauda short, tapering, almost triangular - Myzus.

3.Aphidini.

Antennae about as long as body; nectaries long and tapering, longer than cauda - Aphis.

Antennae shorter than body; nectaries very short in above but slender and swollen in middle - Hyalopterus.

Antennae much shorter than body; nectaries cylindrical and long, slightly constricted at tip - Coloradoa.

C. Callipterinae.

Sixth antennal segment with more or less variable spur; antennal tubercles present - Tribe Callipterini, 1.

Sixth segment (Sipha has only 5) without a spur; antennal tubercles absent.

Row of dentate-like spiracles along sides of abdomen. Numerous fine, short hairs on antennae, body, and legs Tribe Pterocommini, 2.

Spiracles not prominent. Finer and more hair-like bristles, heavier antennae and legs than 2. Tribe Chaitophorini, 2.

Genera of Above Trives.

1. Callipterini.

Antennal tubercles prominent; antennae always exceedingly long. Nectaries at least one-fourth length of body,

swollen in the middle - Drepanosiphum.

Antennal tubercles wanting or very small; antennae variable in length.

Antennae longer than body; spur of sixth segment about as long as segment. Nectaries much broadened at base - Eucallipterus.

Antennae shorter than body, spur very short, segment short. Nectaries about as long as broad, on a broad base - Callipterus.

2. Pterocommini.

Nectaries swollen or vasiform - Melanoxantherium.

3. Chaitopherini.

Antennae 6-segmented. Spur of sixth at least 3 times length of segment, Cauda knobbed at tip. Nectaries longer than sixth segment. Cauda not constricted at base of knob - Chaitophorus.

3. SOME APHIDES OF ECONOMIC IMPORTANCE IN ORCHARDS.

Schizoneura lanigera - Woolly aphis. Apple.

Aphis pomi - Green apple aphis. Apple, pear.

Aphis mali - Eastern green apple aphis. Apple.

Aphis sorbi - Rosy apple aphis. Apple.

Aphis persicae-niger - Black peach aphis. Peach.

Aphis setaria - Rusty plum louse. Plum.

Aphis bakeri - Clover aphis. Apple, pear.

Aphis avenae - European grain louse. Apple.

Aphis fitchii - Apple.

Aphis pruni - Plum louse. Plum.

Aphis medicaginis - Sweet clover aphis. Apple.

Aphis prunicola - Plum.

Aphis gossypi - Melon louse. Melon, cucumber, squash.

Aphis forbesi - Strawberry root louse. Strawberry.

Aphis citri - Orange.

Phylloxera vastatrix - Grape aphis. Grape.

Myzus persicae - Green peach aphis. Peach, plum, cherry.

Myzus cerasi - Black cherry aphis. Cherry.

Myzus ribis - Currant aphis. Currant, goosberry.

Nectarophora viticoli - Grape inhabiting aphis. Grape.

Nectarophora rubi - Blackberry.

Myalopterus arundinis - Mealy plum louse. Plum.

Phorodon humuli - Hop plant louse. Apple, Hop.

Rhizobius lactucae - Lettuce earth louse. Lettuce.

Callipterus mucidus. Apple.

SECTION 111.

SPRAYS FOR COMMON ORCHARD APHIDES AND THEIR RELATIVE VALUE.

1. Remedies For Infected Nursery Stock.

The Woolly Aphis, Schizoneura lanigera, and the Black Peach Aphis, Aphis persicae-niger, are the two common plant lice found on nursery stock. The woolly aphis has two distinct forms which may live simultaneously - one form inhabiting the trunk and branches above ground and the other living underground on the roots. The two forms are nearly always found together, but the root form is more serious and much more difficult to get rid of. This is the form most commonly found on nursery stock.

The black peach aphis also has a root form and an aerial form, the former being the more serious and the one frequently found on nursery stock.

These aphides may infest the nursery stock in the egg state or in the active state. Any treatment that will destroy the eggs will kill the live insects. Eggs of the other aphides are also sometines found on nursery stock.

Remedies:

1. Fumigation with hydrocyanic acid(HCN) is an effective treatment. (1,13,19,28) It should be done in a small closed room or box. Place the acid and water together in a jar in the room, drop in the cyanide and leave quickly to avoid the intensely poisonous fumes. Use 1 oz. of cyanide for each 100 cu. ft. for 1 hour. (28) Formula (19,20):

Cyanide of potassium - 1 oz.

Sulfuric acid - 2 oz.

Water - 4 oz.

2. Dipping in strong tobacco water (13,18,26), kerosene emulsion (6,13,22), whale oil soap (13 lb. soap to 6 gal. water) lime-sulphur (36, commercial preparation 1 part, water 10 parts), Black Leaf (36, 1 part to 60 of water), or hot water at 130 to 150 degrees F. for a few seconds. (36,22)

3. Puddle in thin mud strongly impregnated with tobacco solution. (18)

4. Kerosene emulsion.

(1) 7 to 10 percent oil, especially recommended for woolly aphis on nursery stock, (21) applied with force.

(2) 15%. Thoroly wash roots and dip for 1 1/2 minutes in the emulsion. (10)

Discussion:

In regard to the Kerosene emulsion spray (No 4 above) Colo. Bulletin 133 says: "We have found the ordinary dipping process quite ineffectual in cases of severe infestation on account of the protection afforded by the woolly secretions, but we have had perfect success by untieing the bundles and forcfully spraying the trees upon roots and tops with kerosene emulsion (7 to 10 percent oil) or one of the tobacco or soap preparations used for top treatment". (17)

To succeed in making kerosene emulsion, "we must always use soft water, must have it hot, and if soft soap is at hand, the emulsion will be speedily and easily formed". (10)

2. Remedies For Destruction of Eggs.

The eggs of most plant lice, at least, are bright green in color when laid, but the sun affects them by making them shining black. (11,17,18,22) They are oval in shape and about 1-40 of an inch long (17) and are deposited in rough places in the bark, in the axils or scales of the buds, or on the surfaces of rapidly growing shoots. The egg of the woolly aphis is of a brown color and about twice as long as wide. (21) The eggs are difficult to kill and some solutions strong enough to accomplish this would badly injure the foliage. So the following sprays are for application during the dormant season.

Remedies.

1. In pruning remove eggs that may be seen easily. (11,16) Some aphides deposit the most of their eggs on terminal twigs (37), where they are easily removed. Prunnings should be collected and burned.

2. Petroleum oil. (23):

Whale oil soap 1/2 lb. or hard soap 1 qt.

Soft water 1 gal. Petroleum 2 gal.

Dilute with 1 or more parts water.

3. Whale oil soap (34) 2 lbs. per gal. of water.

m4. Black leaf. 2 1/2 to 4 percent with water (17). 1 to 25-30 parts (3).

5. Lime-sulfur (3,4,7,8,11,17,18,34,35,37)

(1) Yearbook U. S. Dept. of Agriculture, 1908.

Stone lime - 2 lbs. Sulfur - 15 lbs.

Water to make 15 gal.

(2) Me. Bulletin 383: Apple Tree Insects of Maine. 1910

1 (lb. lime) - 1 (lb. sulfur) - 3 (gal. water).

(3) Ida. Spraying Calendar. 1908.

3-3-10

(4) Colo. Bulletin 133; A Few Orchard Plant Lice. 1908.

1-1-2 or 1-1-3.

(5) Fruit Growing in Arid Regions. 1909

1-1-2 or 1-1-3.

(6) Ida. Bulletin 40: Winter Spraying For Apple Aphis.

1-1-2 and 1-1-4 excellent. The latter, Piper formula, especially recommended.

Discussion:

"Excellent results have followed the use of lime-sulfur, almost all of the eggs of the apple aphis having been destroyed by a thoro application once in spring shortly before the buds open."(37) "Prof. J. M. Aldrich has shown that lime-sulfur wash is effective in destroying on twigs and branches the winter eggs of the aphides affecting the foliage of the apple."(4)

"Prof. Aldrich seems to have been the first to report success from winter treatment of orchards for the destruction of the eggs of plant lice. "(17) He says,"It should be remembered that eggs are laid on only a few trees, and usually on only a few branches of these, often on only one twig in the tree. Winter spraying will not generally be thoro enough unless the trees are small and the places to spray are definitely known, and can be easily reached. Young trees are preferred for deposit of eggs." (7)

Four publications (3,17,18,35) mention lime-sulfur as be-

ing suitable for treatment especially of woolly aphides in the dormant season. It then may be in the egg stage, or active in climates not too cold.

Wisconsin Bulletin 190, "Common Insect Pests of Fruit in Wisconsin", says that 15% kerosene emulsion will destroy the eggs of the common green aphis of the apple in the eastern states. This is Aphis mali. But concerning Aphis pomi, the common green apple aphis of the West, Colorado bulletin 133 says, "In our experiments for the destruction of the eggs we have found the oil emulsion useless, killing only in very high strength, if at all." Prof. Aldrich had the same experience with the eggs of Aphis pomi. (33)

3. Remedies For Plant Lice Above Ground.

A. Plant Lice Affecting Trunk and Limbs.

The woolly aphis of the apple differs from other plant lice that are of economic importance in Horticulture from the fact that it does not attack the leaves of the plant but the bark of the limbs or of the roots." The bark apparantly ceases to grow at the point of attack, but swells into a large ridge about the cluster of lice, leaving them in a shelterer pit. The lice also frequently congregate in the axils of leaves and the forks of branches." (Comstock quoted in 22.)

"Injuries from the woolly aphis are almost entirely confined to the apple, even the wild crab not being so liable to attack, or at least injury by it." (22) "Of all the varities grown in Colorado the Missouri Pippin seems to be the worst infested, and Northern Spy is practically exempt. In a few instances slight infestation has been found in pears." (10,17) "Northern Spy never seems to be seriously affected." (3)

These lice above ground are apparantly easily controlled. (22,26,33,37) "Whenever this louse can be reached by sprays it may be destroyed like other plant lice (3,also 22,36), but the spray must be applied with sufficient force to remove or penetrate the woolly covering."(3, also 22,36) All remedies are more effective if applied warm. (37)

Remedies:

1. Washes applied to affected parts with a stiff brush or a piece of cloth:

(1) Pure kerosene. (13)

(2) Kerosene emulsion. (8,15,16,33)

(3) Lime-sulfur. (5,18) 5-1-2(5)

(4) Alkali soap solution - Soft soap made into a thick paste with a strong solution of washing sode in water.

2. Tobacco decoction gives good results. (8,17,26,33,37)

(1) Stems or dust - 2 lbs. or leaves 1 lb.
Water - 4 gal. (16,37)

(2) Fresh stems or leaves - 3 lbs.
Water, after boiling - 5 gal.

(3) Summer, leaves - 1 lb. or stems 2 lbs.
Water - 4 gal. Little soap or lysol.

3. Blackleaf highly recommended. (1,3,8,10,17,37)

(1) Growing season.

(a) "1 to 75 uniformly successful." (17)
"1 to 100 seldom fails to give good results." (17)

(b) 1 to 60 or 70. (1,3,8,17,37)

(c) 1 to 70, with 3 lbs. potash-whale-oil soap per 70 gal. (10)

(2) Dormant season. 1 to 25-33. (33)

4. Lime-sulfur. (8,35)

(1) Dormant.

(a) 2-1-1 Dilute 1 to 10. (8)

(b) 3-3-10. (35)

(2) Summer. Neither lime-sulfur or lime washes have proved successful. (17).

5. Whale Oil Soap. (10,13,26,33,37)

(1) 1 lb. to 6-8 gal. of water. (26,37)

(2) 1 to 5-10

(3) 1)1bs. Potash-whale-oil soap) to 6, applied warm if possible. (10)

6. Commercial soaps. (17,37)

Goodes Whale Oil Soaps are Bowkers Tree Soap 1 lb. to 6-8 gal. water.

7. Scalecide (17) - "3 or 4 % very effective."

8. Distillate. 28 to 34 degrees Baume (28, date 1911). Dormant season. "Use only with power sprayer with good agitator. "(28) 10 or 20 gal. to 200 gal. water.

9. Kerosene emulsion. (1,2,6,8,11,12,15,17,18,19,20,21,24, 25,26,27,28,33,37). This is by far the most popular remedy.

(1) Dormant season.

(a) 1 to 5. (18,20,24)

(b) 1 to 3. (12)

(c) Soap 1/2 lb. Hot water 1 gal. Kerosene 1 gal. Dilute with 5 to 10 water.

(2) Growing season.

(a) 1 to 10. (26)

(b) Kerosene 2 gal. Whale oil soap 2 gal. Water 1 gal. Dilute 1 to 12. (8,27)

(c) (11,20,25,28,37)

(11) 1/2 lb. whale oil soap. 1 gal. water. 2 gal. kerosene. Dilute 10 to 25 times.

(20) Dilute same 8 to 15 times.

(25) Dilute same 10 to 15 times.

(37) Dilute same to 30 gal.

(28) Dilute same to 15 to 25 gal.

10. Sulfate of nicotine or Nico-Fume - 1 to 1,000. (16)

11. Tanglefoot bands around trunks of trees. Put a light band of cotton batting under the Tanglefoot band. Highly recommended (17) as it prevents an exchange between the aerial and the root forms. Manufactured by O. and W. Thum Co., Grand Rapids, Mich. Use of bands is prefered to daubing preparation on the tree trunk.

Discussion:

Colorado bulletin 133, entitled "A Few Orchard Plant Lice", is the best treatise on the treatment for plant lice that I have seen. The following is from that bulletin: "Just before the buds open in the spring, spray very thorely with a 7% kerosene emulsion, Black leaf dip-1 lb. to 60 gal. of water- or a good whale oil soap - 1 lb. to 6 gal. of water. Spray the entire trunk and also the ground about the crown of the tree. Immediately after treatment apply a Tanglefoot band over cotton so as to prevent the upward migration. If the lice become very numerous at any time upon the tops spray them forcefully with a 7% emulsion or Blackleaf - 1 part in 70 parts water." "This band, in connection with the spring spraying mentioned above, we believe to be the surest method of freeing the tops of woolly aphides".

Kerosene Emulsion. Four authorities say that the woolly aphides on the top are easily disposed of with kerosene emul-

sion (18,22,26,33). One of these adds:"Or with any of the washes recommended for plant lice, as tobacco decoction or strong soap wash." (37) "When properly made a good kerosene emulsion has no superior, so far as we have been able to determine, and it penetrates the woolly covering better than most insecticides." (17, also 11) It is best applied warm. (17,22)

Black Leaf. "Black leaf is, all things considered, by far the best spray for plant lice that has yet been introduced. It gives no better satisfaction than kerosene emulsion when properly made. Blackleaf has been given a thoro test by many orchardists and has given universal satisfaction." (3) Another effective compound consists of Blackleaf Tobacco Extract. (see formula above, 3(1)(c).) This is very easily and cheaply prepared. As in all cases of the use of sprays, much force should be used im making the application, for, as the effectivness depends upon contact, the inseciticide must strike all the lice, which will not be true unless a high pressure is used".(10)

Sulfate of nicotine or Nico-Fume. "I have found a thoro application of either in the proportion of 1 to 1000 to either Aphis pomi or Schizoneura lanigera will kill 100% of those actually treated. I find however by adding a small amount of soap, 1 lb. to 50 gal., the efficiency of these tobacco extracts is greatly increased." (3)

"Rubbing the trees (with kerosene emulsion) is a very good method of destroying the aphides on the tops, especially when care is taken to get into all the crevices." (21)

Remedies For Plant Lice Above Ground (continued).

B. Plant Lice Affecting Foliage And Tender Shoots.

There are numerous species of aphides of this class. (See appended list of commonest aphides of economic importance Sec. 11,3) Those of special importance in orchards, especially in the West are:

1. Black peach aphis - Aphis persicae-niger.
2. Green apple aphis (West) - Aphis pomi.
3. Green apple aphis (East) - Aphis mali.
4. Green peach aphis - Myzus persicae.
5. Black cherry aphis - Myzus cerasi.
6. Rosy apple aphis - aphis sorbi.
7. European grain louse - Aphis avenae.
8. Clover aphis - Aphis Bakeri.
9. Mealy plum louse - Hyalopterus arundinus.
10. Rusty plum louse - Aphis setaria.
11. Currant aphis - Myzus cerasi.

All these aphides require much the same treatment. In a great many cases the publications reviewed did not mention any particular kind of aphis in prescribing treatment.

"The black and brown species are much more difficult to kill. (22) The green apple aphis (A. pomi and A. mali) is considered quite sensitive to the sprays. (2,13,33)

It is important to keep in mind two points in this connection. First, treatment should be given as soon as possible after the young aphides are seen, which will generally be about the time the buds open. Later, when the leaves become curled, it is

difficult to reach them, Second, the remedies kill only where they come into actual contact.

Formulae, growning season:

A. Green apple aphides (A. pomi and A. mali).

1. Tobacco decoction. (1,2,3,5,6,8,11,13,15,18,26,30,33,35)

(1) 1 (pound) - 2(gal. water). (4,35)

(2) 3-5. (33)

(3) 1-5 to 10. (11)

(4) 1 to 2 with 1 or 2 lbs. whale oil soap. Dilute to 50 gal. (18)

(5) Strength, color of strong tea. (2,15,26)

2. Blackleaf. (1,3,14,16,36)

(1) Dilute to 1 to 70. (3,15)

(2) 1 to 60. (36)

3. Whale oil soap. (6,9,18,19,26,29,30,32,34,35,36)

(1) Dilute 1 to 6. (7,11,14,26,29,30)

(2) 1 to 8. (29)

(3) 1 to 7. (9)

(4) 1 to 4. (18)

(5) 1 to 15. (34)

4. Soap emulsion. (2,11,20,33)

(1) Soft soap - 1 qt., 2 qt. water, 1 pt. kerosend.Dilute 1.

(2) Hard soap -

(a) 1/2 lb.,2 qt. water, 1 pt. kerosene. Dilute 2. (2)

(b) 1 lb. to 8 (gal. water). (11,20)

(c) 1 to 3-6. (33)

5. Kerosene emulsion. (2,6,8,11,13,14,15,18,19,20,26,29,30, 33,36)

(1) Pure emulsion.

(a) Dilute 1 to 10. (26)

(b) 1 to 12. (30)

(c) 1 to 15. (36)

(d) 1 to 5. (18)

(2) Milk kerosene - Kerosene 2 gal., sour milk 1 gal. Dilute 12 to 15 times. (2)

6. Soap kerosene. (11,13,14,20,29,33,34)

Kerosene 2 gal., 1/2 lb. whale oil soap, 1 gal. water.

(1) Dilute 6 to 9 times. (13,14)

(2) 15 times. (11)

(3) 8 to 12 times. (20)

Kerosene 2 gal., 1 lb. whale oil soap, 1 gal. water.

(1) Dilute 10 to 20 times. (34)

(2) 15 to 20 times. (33)

7. Sulphate of nicotine or Nico-Fume. (16)

1 to 1600, with soap 1 lb. to 50 gal.

B. Black Peach Aphis-Aphis persicae-niger.

1. Tobacco decoction. (15,17,18,26,31)

See above A, 1, formula (3)

2. Blackleaf. (1,3,6,17,35)

(1) Dilute 1 to 70. (3,20)

(2) 1 to 65. (17)

(3) 1 to 80. (31)

3. Whale oil soap. (3,12,19,22,26,31,35)

(1) Dilute 1 to 4. (22)

(2) 1 to 6. (26)

(3) 1 to 7. (12)

(4) 1 to 8. (31)

4. Kerosene emulsion. (1,6,12,15,17,18,19,22,26,27)

(1) Dilute 1 to 5-7. (12,18,22)

(2) 1 to 10. (26)

(3) 1 to 15-20. (17)

C. Black Cherry Aphis-Myzus cerasi.

1. Tobacco decoction. (5,8,15,17,18,26)

See above A, 1, formula (3)

2. Blackleaf. (35)

1 to 70.

3. Whale oil soap. (9,18,19,26,32,35)

(1) 1 to 4. (18,32)

(2) 1 to 6. (26)

(3) 1 to 7. (9)

4. Kerosene emulsion. (6,8,9,15,17,18,19,20,24,36)

(1) Dilute 1 to 5. (18)

(2) 1 to 10. (26)

(3) 2 to 1 with 1 lb. hard soap. Dilute 10 to 20 times.(18)

(4) 2 to 1 with 1/2 lb. hard soap. Dilute to 50 gal. (20)

D. Plant lice in General(affecting foliage and tender shoots)

1. Tobacco Decoction. (4,11,23,22)

(1) 1 (lb. stems or leaves) to 1 gal. (4)

(2) 1 to 1-2.(23).

(3) 1 to 2, diluted 5 to 10 times. (11)

2. Whale oil soap. (11,22,27,28)

(1) 1 lb. to 6-8 gal. (11,28)

(2) 1 to 5-15. (28)

3. Kerosene emulsion. (11,22,23,25,27,28,32)

(1) 2 gal. kerosene, 1 gal. water, dilute 15 times. (4, 11,23,32)

(2) As above diluted 15 to 25 times. (28)

(3) As above undiluted (See discussion following).

Discussion:

The above remedies are for application as soon as possible after the insects are discovered. While in most cases the season mentioned is summer, or while trees are in full foilage, probably some of the preparations applied so late will injure the leaves.

The remedies given under A. B. and C. were mentioned by the authors as being especially suitable for the respective aphides named. However, in many cases the same treatment was mentioned as suitable for other aphides. Remedies under A. are suitable for green aphides. Those under C. and D., in nearly all cases at least, are appropriate for any of the plant lice affecting foliage and tender shoots. Remedies for "Plant Lice in General", D, apply to all aphides of this class, except those mentioned under B. and C.

Soap Solution. Concerning the green and rosy apple aphides Va. Circular 7, 1909, says, "A weak soap solution, made by dissolving 1 pound of whale oil or potash soap in 6 to 8 galons of water, is the simplest and most satisfactory remedy of this pest."

Tobacco and Whale Oil Soap. "Tobacco decoction with whale

oil soap make an almost perfect remedy." (30)

Black Leaf and Kerosene. See quotation under Blackleaf included in "Pland Lice Affecting Trunks and Limbs." (3)

Tobacco, Kerosene, and Whale Oil Soap. "The best treatment for aphides is very thoro spraying with tobacco decoction, kerosene emulsion, or whale oil soap." (18) Tobacco decoction is made by boiling the leaves, stems, or powder in water.

Kerosene Emulsion. "This emulsion diluted with from 12 to 15 times ist own bulk of water, is an excellent summer remedy for plant lice." (32) "Nothing is better than kerosene emulsion, which, when diluted about 10 times with water, kills all the young lice and the adults of the common species, providing, however, that the insects are reached with the spray, which is sometimes difficult if they are hidden in curled and twisted leaves." (16) "Against plant lice and other soft bodied insects that suck, this is an almost perfect remedy." (32)

Dipping. "If leaves are badly curled by the lice, the branches should be bent down and dipped into the liquid." (16)

Sulphate of Nicotin or Nico-Fume. See quotation under treatment for woolly aphis. (16)

4. Remedies For Root or Underground Lice.

As stated under "Remedies For Infected Nursery Stock" the woolly aphis, Schizoneura lanigera, and the black peach aphis, Aphis persicae-niger, have underground forms. These are more serious than the aerial forms because, (1) they are harder to get rid of and (2) they generally do more injury to the trees.

As with either of these aphides the root form can spread to the top or vise versa, it is necessary to combat the insect in both places, if it exists there, simultaneously; or if it exists in only one form, to prevent the other form from getting started.

"The root treatment is not completely reliable." (34) "Root treatments are temporaty in their effects." (17) "Lice are seldom found upon the roots more than 10 to 18 inches from the surface of the ground" or for more than 2 or 3 feet out from the trunk of the tree. (17)

Remedies for the two aphides are identical. Practically every remedy named for either is prescribed for both, but in some cases not for both by the same author.

Remedies:

1. Hot water (2,5,6,22) - 130 to 150 degrees. (2) "Water at near the boiling point may be applied about the base of young trees without the slightest danger of injury to the trees" (22) Lay the roots bare for some distance around the tree and use in sufficient quantities to wet the soil thoroly.

2. Kerosene emulsion. (2,6,8,10,17,33)

(1) 10% to 15%.(33) (2) 15%, 3 to 5 gal. per tree. (10)

3. Unleached wood ashes.(2,7,19,26,31).1/2 to 1 lb. per tree. (12) Applied as a top dressing for some distance around tree.

4. Kainit, a potash fertilizer. (6, 12,26,34) Heavy top dressing scattered for some distance around tree, 10 lbs. per tree. (26) Do not get it against the trunk.

5. Tobacco decoction. (a,14,18,19) Expose roots and thoroly soak. "Blackleaf 40," 1 pt. to 200 gal. (21)

6. Fine tobacco dust. (2,6,9,11,12,13,14,15,18,20,24,25,26, 28,31,33,34) Apply to exposed roots and cover.

(1) 1/2 to 5 lbs. per tree. (15)

(2) 2 lbs. (24)

(3) 1 lb. (31)

It is well to irrigate the trees afterwards.

7. Carbon disulphide. (2,12,17,19,25,28) Pour into holes made in ground around trunk.

(1) Teaspoonful per sq. ft. (2)

(2) Two holes with 2 oz. in each. (12)

(3) Teaspoon in holes 3 or 4 ft. apart. (28)

8. Lye water (33) - 1 lb. per bucket of wateron exposed roots.

Discussion:

Hot Water. "Most successful." (5) "The most generally recommended measure hitherto is the use of hot water; and that, while being both simple and inexpensive, is thoroly effective, as has

been demonstrated by practical experience. (22)

Tobacco Dust. "Tobacco is probably the best remedy; it must be in dust, not pieces. (15) "The procedure promising most is uncovering the roots as completely as possible and working in tobacco stems." (32) Tobacco dust for this purpose may be obtained from H. A. Stroothoof, 116 West St., New York.

Kerosene Emulsion. "Experiments demonstrate conclusively that kerosene soap emulsion at 10% and 15% strength was much superior to all other treatments." (33)

"For orchard trees a hole 6 inches deep and 3 feet, more or less, in diameter, according to age and size of trees, is dug about the tree, and from 3 to 5 gallons of the 15% emulsion is poured into this excavation. As soon as the liquid has disappeared, the whole is filled. All of the lice that are touched are surely killed. Those distant from the tree may not be killed, but the odor and presence of the emulsion, which persists for months, will prevent their approaching the tree. One application a year will suffice, and it was found that in 2 years the lice were all destroyed and the tree in full health. This treatment should be given in late spring, as the trees are then in such thrift that they are not injured by it. This is not true when the trees are dormant." (10)

Carbon Disulphide. "This insecticide has been reported successful against plant lice upon roots. The results seem to indicate that such a treatment would be profitable in cases of severe root infestation, but not as effective as kerosene emulsion or tobacco decoction applied directly to the exposed tree

roots. The use of the substance is not advised except in extreme cases since a little carelessness may injure the tree. "(Miss. Bull. 35).

Tanglefoot Bands. See Division 3, A, Remedy 11, and Discussion.

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